

CLAIMS

We Claim:

- 1 1. A method for searching a database for data satisfying a property specified
2 by a query, the database containing data within an application domain and encoded in a
3 group theory representation, comprising:
4 formulating the query in terms of the group theory representation;
5 executing the query on the data in the database within the application domain
6 and encoded in the group theory representation to identify zero or
7 more database elements and group elements in the group theory
8 representation satisfying the query; and
9 outputting the zero or more database elements and group elements satisfying
10 the query.
- 1 2. The method of claim 1, wherein the data within the application domain are
2 represented as one or more augmented clauses, where each augmented clause has a pair
3 (c, G) including a database element c and an associated group G of group elements g
4 acting on c .
- 1 3. The method of claim 2, wherein the group elements g are permutations.
- 1 4. The method of claim 2, wherein the query is of a type "find an element x
2 that satisfies a property P " and wherein formulating the query in terms of the group
3 theory representation comprises:
4 formulating the query as a type "find database element c and element g of the
5 associated group G , such that $g(c)$ satisfies property P ."

1 5. The method of claim 1, wherein outputting the zero or more database
2 elements and group elements satisfying the query comprises:
3 converting the zero or more database elements and group elements satisfying
4 the query from the group theory representation to a native
5 representation of the data within the application domain; and
6 outputting the zero or more converted database elements satisfying the query.

1 6. The method of claim 5, wherein a database element satisfying the query
2 includes a database element c and a group element g of an associated group G , wherein
3 the converting comprises:
4 constructing $g(c)$ to produce the database element in its native representation.

1 7. The method of claim 1, wherein the query comprises a high-level query,
2 the method further comprising:
3 generating one or more low-level queries from the high-level query, wherein
4 the formulating step formulates the low-level queries in the group
5 theory representation and wherein the executing step executes the low-
6 level queries on the data in the database.

1 8. The method of claim 7, the method further comprising:
2 generating one or more additional low-level queries responsive to one or more
3 results of one or more previously-executed low-level queries, wherein
4 the formulating step formulates the one or more additional low-level
5 queries in the group theory representation and wherein the executing
6 step executes the one or more additional low-level queries on the data
7 in the database.

1 9. The method of claim 1, further comprising:
2 representing the zero or more database elements and group elements satisfying
3 the query as a subgroup, wherein some elements are described

4 explicitly and remaining elements are described in terms of the
5 explicitly described group elements.

1 10. The method of claim 1, wherein the data within the application domain
2 describe a digital logical device and wherein the query performs a verification and/or test
3 of the device.

1 11. A system for using group theory to manipulate data in a database,
2 comprising:
3 a query execution module for executing a query on the data in the database,
4 wherein the data in the database are within an application domain and
5 are encoded in a group theory representation and wherein the query
6 specifies a search for database elements and group elements satisfying
7 a property specified by the query.

1 12. The system of claim 11, further comprising:
2 a database construction module for receiving input data within the application
3 domain in a native representation and for encoding the input data in a
4 group theory representation.

1 13. The system of claim 12, wherein the input data in the group theory
2 representation include one or more augmented clauses, where each augmented clause has
3 a pair (c, G) including a database element c and a group G of group elements g acting on
4 c .

1 14. The system of claim 13, wherein the group elements g are permutations.

1 15. The system of claim 13, further comprising:
2 a query formation module for receiving an input query, the input query
3 specifying a search for database elements satisfying a property in a
4 native representation of the data, and for converting the input query

5 into a search for equivalent database elements and associated group
6 elements in the group theory representation of the data.

1 16. The system of claim 15, wherein the input query is of a type “find an
2 element x that satisfies property P ” and wherein the converted input query is of a type
3 “find database element c and element g of an associated group G , such that $g(c)$ satisfies
4 property P .”

1 17. The system of claim 11, wherein the query execution module identifies
2 zero or more database elements and group elements satisfying the query and further
3 comprising:
4 a result construction module for converting the zero or more database
5 elements and group elements satisfying the query from the group
6 theory representation to a native representation of the data within the
7 application domain.

1 18. The system of claim 17, wherein a database element satisfying the query
2 includes a database element c and a group element g of an associated group G , and
3 wherein the result construction module constructs $g(c)$ to produce the database element in
4 its native representation.

1 19. The system of claim 11, further comprising:
2 a query formation module for receiving a high-level input query, and for
3 generating one or more low-level queries responsive to the high-level
4 input query, the one or more low-level queries specifying searches for
5 database elements and group elements in the group theory
6 representation of the data.

1 20. The system of claim 19, wherein the query formation module is further
2 adapted to generate one or more additional low-level queries in response to one or more
3 results of one or more previously-executed low level queries.

1 21. The system of claim 11, wherein the query execution module identifies
2 zero or more database elements and group elements satisfying the query and further
3 comprising:

4 a result construction module for representing the zero or more database
5 elements and group elements satisfying the query as a subgroup,
6 wherein some elements are described explicitly and remaining
7 elements are described in terms of the explicitly described group
8 elements.

1 22. The system of claim 11, wherein the data within the application domain
2 describe a digital logical device and wherein the query performs a verification and/or test
3 of the device.

1 23. A computer program product comprising: /

2 a computer-readable medium having computer program code embodied
3 therein for encoded thereon computer program modules for using
4 group theory to manipulate data in a database, the computer program
5 modules comprising:
6 a query execution module for executing a query on the data in the
7 database, wherein the data in the database are within an application
8 domain and are encoded in a group theory representation and
9 wherein the query specifies a search for database elements and
10 group elements satisfying a property specified by the query.

1 24. The computer program product of claim 23, the computer program
2 modules further comprising:

3 a database construction module for receiving input data within the application
4 domain in a native representation and for encoding the input data in a
5 group theory representation.

1 25. The computer program product of claim 24, wherein the input data in the
2 group theory representation include one or more augmented clauses, where each
3 augmented clause has a pair (c, G) including a database element c and a group G of
4 group elements g acting on c .

1 26. The computer program product of claim 25, wherein the group elements g
2 are permutations.

1 27. The computer program product of claim 25, the computer program
2 modules further comprising:
3 a query formation module for receiving an input query, the input query
4 specifying a search for database elements satisfying a property in a
5 native representation of the data, and for converting the input query
6 into a search for equivalent database elements and associated group
7 elements in the group theory representation of the data.

1 28. The computer program product of claim 27, wherein the input query is of
2 a type "find an element x that satisfies property P " and wherein the converted input query
3 is of a type "find database element c and element g of an associated group G , such that
4 $g(c)$ satisfies property P ."

1 29. The computer program product of claim 23, wherein the query execution
2 module identifies zero or more database elements and group elements satisfying the
3 query, the computer program modules further comprising:
4 a result construction module for converting the zero or more database
5 elements and group elements satisfying the query from the group
6 theory representation to a native representation of the data within the
7 application domain.

1 30. The computer program product of claim 29, wherein a database element
2 satisfying the query includes a database element c and a group element g of an associated

3 group G , and wherein the result construction module constructs $g(c)$ to produce the
4 database element in its native representation.

1 31. The computer program product of claim 23, the computer program
2 modules further comprising:
3 a query formation module for receiving a high-level input query, and for
4 generating one or more low-level queries responsive to the high-level
5 input query, the one or more low level queries specifying searches for
6 database elements in the group theory representation of the data.

1 32. The computer program product of claim 31, wherein the query formation
2 module is further adapted to generate one or more additional low-level queries in
3 response to one or more results of one or more previously-executed low-level queries.

1 33. The computer program product of claim 23, wherein the query execution
2 module identifies zero or more database elements and group elements satisfying the
3 query and further comprising:
4 a result construction module for representing the zero or more database
5 elements and group elements satisfying the query as a subgroup,
6 wherein some elements are described explicitly and remaining
7 elements are described in terms of the explicitly described group
8 elements.

1 34. The computer program product of claim 23, wherein the data in the
2 application domain describe a digital logical device and wherein the query performs a
3 verification and/or test of the device.